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Presentation Type: In Person, Poster

Topic: Recent ocean salinity science advances

Title: Using ECCO State Estimate to understand the decadal variation of upper-ocean salinity in the Southeast Indian Ocean

Abstract: Argo measurements illustrate pronounced decadal variation of salinity in the southeast Indian Ocean (SEIO) that is coherent in the upper 70 m, with freshening during 2004–2010 followed by salinification during 2011–2019. The SEIO decadal salinity variation contributed to over half the magnitude of decadal sea level variation in this region. Previous studies suggested several possible factors contributing to SEIO decadal salinity signal: SEIO local winds, remote winds in the tropical Pacific forcing the Indonesian Throughflow (ITF) that advects salinity signal into the SEIO, SEIO local freshwater flux, remote freshwater flux over the Maritime Continent (MC). These studies did not agree on a key forcing mechanism. Here, we attribute decadal variation of SEIO salinity by isolating the contributions of freshwater and wind stress forcings through sensitivity experiments using the ocean modeling and state estimation system of the Estimating the Circulation and Climate of the Ocean (ECCO) project. Our causality analysis reveals that Maritime Continent surface freshwater flux is the key for decadal variation of SEIO salinity. Decadal variation in local or remote winds and SEIO local freshwater flux, implicated to be important by some previous studies, play little role. Salt budget analysis suggests that the advection of the salinity gradient, induced by the decadal variation of freshwater content over the MC, into the SEIO is the main oceanic process transmitting the MC water cycle effect to the SEIO.

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